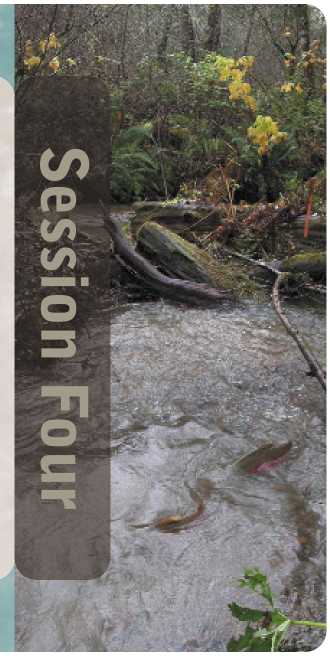

Instream treatment (e.g., woody debris, rootwads, boulders, side channels, pools, spawning gravel, nutrient augmentation), conversion to non-structural flood control (e.g., meander zones)

Costs of Restoration Work in an Urban Environment

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ABSTRACT

This paper describes cost factors that are particular to local governments completing salmon habitat improvement projects in watersheds that surround a major city. King County, Washington surrounds the Seattle metropolitan area, and is the most populated and one of the fastest-growing counties in the state. Organizational and policy factors as well as costs resulting from physical characteristics of the project sites are significant determinants of project cost. Also discussed are some of the techniques and strategies that have led to successful projects in the past. Specific examples are drawn from the author's ten years direct involvement in the design and construction of in-stream habitat restoration projects for King County.

INTRODUCTION

King County Water and Land Resources Division's (WLRD) habitat work focuses on streams, rivers and wetlands in urbanizing basins of the Puget Sound lowlands. The Division is involved with a variety of surface water initiatives, of which instream habitat projects are only one part. Types of instream habitat improvement projects include rebuilding streambeds with boulders, gravel, and woody debris, removing or replacing culverts to improve fish passage, installing large woody debris (LWD) for habitat diversity and erosion control, bioengineered bank stabilization, reconnecting a watercourse to its floodplain, and excavating groundwater-fed side channels. LWD may be anchored to the site by partially burying each piece in the streambank or bed, or may be placed unanchored with a crane or helicopter. Most instream projects include an important riparian revegetation component, and many include improvements to wetlands. The Division also designs and constructs regional retention/detention ponds, neighborhood drainage assistance projects, stormwater drainage systems, and flood hazard reduction work. WLRD is also active in proposing policies and regulatory remedies, and in public involvement and education. This broad perspective enhances the range of opportunities and resources for habitat work.

Figure 1. Streambed rehabilitation project under construction. Project design team ecologist checking invert of instream boulder wedge. (Case study project 4)

The combination of physical and organization factors sets a particular environment within which King County staff design and construct habitat improvement projects. This paper highlights the most salient features of that environment, and points out how these features affect project cost and quality.

Physical Setting

King County is located on the east side of the Puget Lowland in Washington State. The Puget Lowland is a north-south trending trough, with Puget Sound along its axis, and the Cascade and Olympic Mountains bordering it to the east and west, respectively.

King County has a marine climate dominated by airflow from the northern Pacific Ocean. Annual precipitation increases from west to east as a result of the orographic rainfall effect of the Cascade Mountains. Annual precipitation ranges from 900 mm (36 inches) near the shores of Puget Sound to 4000 mm (156 inches) at the Cascade Crest. Typically, approximately 70% of precipitation falls between the first of November and the end of February. These climatic conditions support conifer-dominated forests that historically extended from the marine shoreline to alpine tree line.

The streams that drain this forested landscape support many aquatic organisms including five species of salmon (pink [*Oncorhynchus gorbuscha*], coho [*O. kisutch*], chinook [*O. tshawytscha*], sockeye [*O. nerka*], and chum [*O. keta*]), two species of trout (rainbow [*O. mykiss*] and cutthroat [*O. clarki*]), and two species of char (Dolly Varden [*Salvelinus malma* Walbaum] and bull trout [*S. confluentus*]), as well as numerous other vertebrate and invertebrate species.

Since pioneers of European and Asian descent began settling the area in the mid-

1800's, the landscape was altered by agriculture, logging, fishing and coal mining, which were the primary supports of the new economy. More recently, urban and suburban development with its associated infrastructure has had a pervasive impact on rivers, streams and wetlands.

The intensity of residential, commercial, and industrial land development has increased, and so has the degradation of aquatic resources that is an unintended consequence of that development. Many suburbs of Seattle have grown at rates of 30 to 40% over the past decade. Development is most evident in the western portion of the County nearest Puget Sound, and is ongoing in the foothills to the east, where farming is still active. The mountainous eastern part of the County continues to be used for timber harvest and recreation.

Types of stream degradation that have been observed are:

- Natural channels have been dredged, diked, straightened, and/or cleared of LWD
- Wetlands and marine estuaries have been filled and/or drained
- Riparian zones have been cleared or overwhelmed by aggressive introduced plant species
- A variety of fish-impassable structures, including culverts, weirs, and dams, have blocked anadromous fish access to hundreds of kilometers of stream channel
- Water quality has been degraded by a variety of pollutants
- Large areas of impervious surface have altered stream hydrology — increasing flow peaks and probably decreasing base flows

Organizational Setting

The problems listed above have become increasingly obvious to most residents of the area. King County has taken an increasingly active role in protecting and restoring the resource values of rivers, streams and wetlands. King County has done leading-edge work as one of the first jurisdictions to invest considerable energy in watershed planning and in habitat restoration projects.

The projects discussed in this paper were all undertaken with habitat improvement as the primary goal of the work, not as mitigation or as a secondary benefit of infrastructure work. These projects were managed through the Surface Water Engineering and Environmental Services Section of WLRD, now Capital Projects and Open Space Acquisition (CPOSA). CPOSA staff focus on building projects, and work within the context of the larger Division. The overall WLRD mission is "to sustain healthy watersheds, protect wastewater systems, minimize flood hazards, protect public health and water quality, preserve open space, working farms and forests, ensure adequate water for people and fish, manage public drainage systems, and protect and restore habitats." The entire Division is made up of about 200 people, and the CPOSA work group is composed of about 50 people. It is helpful that design, permitting, and construction expertise is focussed in one working group, which also has access to resources in the entire Division. Many of the restoration projects are based on the watershed planning work that was initiated by WLRD (formerly known as Surface Water Management in the 1980's).

HABITAT ENHANCEMENT PROJECTS

Project Identification and Funding

The basin plans often set the context and sequence of projects the CPOSA group undertakes. A comprehensive, persistent watershed planning effort helps ensure that projects are identified and funded from a whole watershed perspective, and that the needs and opinions of citizens, tribes, organizations, and cities are taken into account. In addition to the formal basin plans, projects are identified through citizen input, King County staff observations, referrals from other public agencies, joint studies, and County Council requests.

Project funding must be established before the project design team is brought together. The entire process may take a number of months or even years. Planners from other sections within WLRD generally take the lead in initial project identification and scoping, and in setting an initial budget. Senior ecological and engineering staff from CPOSA are often involved in the process. Project proposals are developed and County Council approves funding. In some cases, projects are funded jointly by the County and one or more cities. Grants from a variety of sources may also be involved in funding a project. If a project requires additional funds for some reason, WLRD must return to Council for approval. The Division has limited ability to move money between projects.

In spite of what is sometimes a time-consuming process, in some cases the County has been able to move quickly to solve an emerging problem. For instance, at Rutherford Creek (see page 161 for case study), the problem was clearly defined, data showed conditions were becoming worse, and a project team and budget had already been assigned to address habitat degradation in the particular watershed. Also, provisions are in place for addressing emergencies immediately.

An organization spends time and money on a project before the project is formally initiated. The planning process is essential to make sure that problems and potential solutions are accurately identified. Extensive consultation is in the public interest, and may be expensive, but is not usually charged to the project budget. A significant time lag between initial project conception and actual mobilization of the project team may mean that the project needs to be re-scoped or that the funding level is not right.

The process attempts to identify and resolve conflicts, for instance disagreements within the community about desired land use and resource values. If unresolved issues must be taken up by the design team, project costs will be increased. As an extreme example, costs of defending a lawsuit can be extremely high and will be charged to the project budget.

Project Implementation and Experience

Habitat enhancement projects vary in size, with budgets ranging from $15,000 to $750,000. A linked series of projects may have an aggregate budget that exceeds $1,000,000. Most projects are less than $400,000 for design, construction, and the initial maintenance and monitoring.

For a typical habitat enhancement project, one to three years are required from the time the project team begins work until design, permitting, and construction of earthwork and planting phases are complete. Monitoring and plant maintenance usually continue for another three to five years.

Project Design Teams

Within CPOSA, a multi-disciplinary design team is assembled after the project is identified and funded. Typically, professionals on the design team include engineers and ecologists, often with support from a geologist and a landscape architect. The size of the core team varies depending on the complexity of the project. Graphics and computer aided design and drafting support are integral to the project team, as are survey staff. The project team often draws on the expertise of professionals working in other sections of WLRD, including for instance wetlands scientists, lake stewardship coordinators, noxious weed control specialists, public involvement facilitators, real estate and open space acquisition specialists and especially watershed planners. The core team works under the direction of a functional manager, and is essentially self-directed, using consultation to arrive at decisions. The core team is responsible for validating the scope and budget, and for project design, permitting, construction, and follow-through.

Staff Continuity

Most design work is done in-house, though design consultants sometimes augment County staff. As often as possible, the same team will work together on a suite of projects in one watershed. This enables the team members to develop a detailed working knowledge of the physical characteristics of the basin, and also the involved landowners and citizen groups. Consistent teams for each watershed greatly enhance the efficiency of the work.

The watershed-level approach has the further benefit of allowing the restoration team to develop long-term working relationships with the regulatory agencies and staff involved in each watershed. For instance, the design team often consults with the fisheries habitat biologist (Washington Department of Fish and Wildlife [WDFW]) and the grading inspector (King County Department of Development and Environmental Services [DDES]) early in the design process. This can make the permitting process more efficient, because regulatory and ecological constraints are identified from the beginning and can be integrated into the project design. Not only is the design team as a whole involved in regulatory and design issues, but an ecologist and an engineer are typically assigned to be on site during construction. CPOSA has a good reputation for compliance with the letter and spirit of regulations, and the design team works closely with the builders to achieve the desired result. Natural materials such as streambed gravels or LWD are highly variable, and it is valuable to have the designer on site when working with them. This practice also means that the plan drawings can be relatively straightforward, describing the intent and general characteristics of the habitat structures, and leaving details of each structure to be field-specified.

Whether a project is going to be bid or is going to be built by County forces, CPOSA projects require formal project plans, not a brief work order. Plans are designed to communicate — to the construction contractor, the field crew, and also to regulatory agencies reviewing sensitive area and fisheries issues. Project teams strive to keep complexity of plans consistent with the complexity of the project. Specialized graphics designed to communicate with the public may be useful, and take time to prepare. The project teams often find basemaps compiled from Geographic Information System (GIS) databases very useful, and these are available much less expensively than in the past.

Our restoration teams are highly interdisciplinary, which means that each design team has the benefit of a variety of perspectives. The commitment to interdisciplinary teams means that a broader range of issues tends to be raised during the design process. This tends to increase the quality of designs, in that construction feasibility, regulatory requirements and ecological benefits are integrated with the original design process. Realistically, this consultative process may significantly increase design costs, since the project budget must pay for each hour working through any protracted disagreements. It is difficult to be certain whether the extra time spent in team discussion saves the project money in the long run. Investing the effort and money in the beginning means that projects are better-prepared for review by regulatory agencies. And, working out truly difficult issues in the broader regulatory or public forum would be more expensive than within the design team.

Regulatory Requirements

King County enjoys a robust permitting environment. Practically by definition, habitat restoration projects are built in ecologically sensitive areas. Projects typically require a Clearing and Grading permit from King County DDES, and a Hydraulic Project Approval from WDFW. A Shorelines Exemption and Water Quality Certification from Washington State Department of Ecology, and a US Army Corps of Engineers (Corps) Nationwide Permit Exemption are often obtained. Since March 1999, when Puget Sound chinook salmon were listed as threatened under the Endangered Species Act (ESA), a formal Biological Assessment and consultation with National Marine Fisheries Service and U.S. Fish and Wildlife Service are often required. The Corps in particular has submittal format requirements that add to project costs, even if special studies are not required. As a matter of policy, and because of the desire to maintain a trust relationship with the agencies, CPOSA teams consult with regulators whenever possible before formal permit applications are submitted. Indian tribes have a great interest in projects that affect fisheries resources, and are organized and effective in commenting on proposed projects through the State Environmental Policy Act (SEPA) process. WLRD is a SEPA lead agency for surface water projects, which means that Determinations of Non-Significance are made and reviewed within the Division, rather than at DDES. This represents a cost saving to the project, because it simplifies the process. The Division is rigorous about adhering to all notification and comment period requirements. Regulatory costs are included in the project's design budget. In general, group decisions and group actions are more time-consuming and therefore expensive than individual decisions.

Whether a project budget bears the full impact of expanded consultation depends on how many of the participants are being paid out of that budget. For instance, Federal and State regulatory staff provide their services to the project for free. Additional expenses come in the form of additional submittal requirements, meetings and studies. King County DDES staff bills the project for time spent in review, field inspection, and monitoring at a substantial rate (currently $132 per hour, the same rate a development project would be charged).

Public Involvement

Some habitat projects are built on private property, and some are built on public property that is often well-loved and much-used. A very few of the habitat projects in King County are in truly remote locations. Landowner relationships are a very significant factor in whether a project will prove to be feasible, and in the ultimate cost of a project. When a project has a broad range of stakeholders or is controversial, a public meeting may be the best choice in working with the community. In any case, explaining the project goals, benefits, and specific actions takes time and may be a significant part of the project budget.

It is generally recognized that we are working with resources that are both valuable and vulnerable. Individual citizens' opinions of WLRD's work vary widely, and are expressed in actions ranging from very negative to very positive. For instance, a recent project involving the helicopter placement of LWD in a ravine near Lake Washington was challenged by a SEPA lawsuit questioning the concept of LWD placement, and was also enhanced by a donation of trees from a neighboring landowner. The donated trees were gratefully accepted. The lawsuit was dismissed about 3 months later, but project staff spent about 60 hours responding. Normally, a project's budget would bear those costs. In this particular case, it was felt that the lawsuit proceeded from a broader dispute, and not from concerns with this particular project. The project team's direct costs of the lawsuit, and the County's legal costs, were paid from separate budgets, but there were ancillary costs that impacted the project. Construction was delayed for one year.

Apart from capital projects, public education and involvement in protecting aquatic resources is an important part of WLRD's mission, and the Division has an on-going investment in public involvement efforts. As part of on-going division-wide programs, hundreds of volunteers donate their time every year to plant native vegetation and to monitor the water quality of small lakes. When appropriate, volunteers will assist with planting newly constructed restoration project sites. Volunteer planting events are especially useful for large sites, where there are thousands of plants to be installed. Team leaders, refreshments, tools, and instructions in how to plant a tree are provided by the county. Adequate parking or shuttle busses must also be provided. The project team shares the costs of coordinating these events with the Public Involvement work group, and the results have been very satisfactory. Benefits include not only getting the plants in the ground quickly at a reasonable cost, but also community involvement and stewardship of sites. Volunteers have also assisted with maintenance of plants in the first years after they are installed through the Habitat Partners program.

Design-Build Projects

Construction labor may be drawn from County roads and parks maintenance crews, general contractors, specialty subcontractors, Washington Conservation Corps (WCC) crews, and volunteers. Members of the design team will also be on site during construction. Their role is not limited to construction oversight, but is likely to include survey, water quality monitoring, and determining the specific placement of habitat structures.

County crews frequently construct habitat projects. In particular, some Roads Maintenance crews have been specialized for habitat and river-related work. Supervisors and the field staff are experienced at working in sensitive areas, and familiar with regulatory constraints and with materials and construction techniques that are specific to habitat projects. Consistently working with the same group improves communication, and helps reduce risks and some uncertainties. Because the design team can work closely with the construction supervisor during the conceptual design phase, construction feasibility issues are addressed early. Considerable administrative costs (often on the order of $5000) are avoided by eliminating the bid process. There is a $70,000 limit set by state law to the size of capital projects that can be undertaken by County forces. The limit is for construction labor, materials, and equipment. The statutory limit does not apply to maintenance projects (for example, work on river levees).

When projects go out to bid and are built by a general contractor, actual construction costs have been found to be comparable to County forces. Public works contracting rules apply, and prevailing wages are paid on all jobs. In addition to the costs of working through King County Finance Procurement Section to bid the job, additional design costs are incurred because the plans and specifications are necessarily more refined in order to serve as Contract Documents. The additional costs vary depending on project complexity, but can easily amount to 100 hours of staff time, which will result in $7000 to $9000 in charges to the project. For many habitat structures, i.e. LWD deflector logs, the plans will say "Field placement under direction of engineer or biologist." Such language increases uncertainty and risk for a contractor, and will increase the bid price. Construction Engineering and Inspection tasks may take approximately the same amount of time as a design-build project, but the work itself will involve more contract administration, and less field design. If the low bidder has not employed a particular technique before, for instance coir wraps with willow cuttings on a streambank, County staff will spend extra time with the construction crew.

The Washington Conservation Corps (WCC) is a particularly important element of the construction labor resources. The WCC is an Americorps program involving youths, aged 18–25, who work full-time on restoration and enhancement projects for King County. Corps members are technically state employees, on contract to the County. CPOSA keeps at least one WCC crew busy all year on planting, watering, and other hand work. Between 1999 and 2003, the cost for a supervised 4-person crew for one week varied from \$3000 to \$5000. An ancillary benefit is that the crew is based in CPOSA, and is coordinated by a CPOSA ecologist. The training they receive provides a good knowledge of habitat projects, native plants, design and construction methods, and ecological issues.

Monitoring

Costs of monitoring for project success in terms of durability, structural stability, and plant survival are covered by the project budget. Costs of more rigorous scientific studies are planned and budgeted separately, and are not addressed in this paper. Such studies may be funded and accomplished by other work groups within the Division, or in cooperation with the University of Washington. Critically assessing the results of completed habitat enhancement projects, and ensuring that significant findings inform future projects is a goal of the work group.

Summary of Cost Factors

The physical and organizational setting in which habitat improvement projects are accomplished has a weighty impact on the costs of those projects. The factors affecting project costs can be separated into three groups – advantages, challenges, and value-neutral factors that must be carefully clarified. Based on CPOSA's experience, there are several strategies that improve the likelihood that enhancement efforts will produce useful results. These working methods usually tend to maximize cost effectiveness, but in some cases the mandate to consult with a wide range of stakeholders, including multiple professional disciplines, private landowners, regulatory agencies, and political representatives will increase costs compared to construction projects with a single owner.

These advantageous strategies include:

- Unified interdisciplinary design teams
- Construction crews experienced in habitat work
- Design-Build capability
- Basin plans underpinning habitat restoration work
- Watershed knowledge brought to bear before and after project initiation
- Working relationship with regulatory agencies – trust
- Working relationship with construction crews – trust
- Washington Conservation Corps

There were organizational factors at work in the last few years (since 1995) that have made it more difficult to complete projects quickly at the lowest possible cost. The Department of Natural Resources underwent a major reorganization, in which the county organization (7,000 employees) merged with Metro (6,000 employees). Resulting staff changes and re-shuffling of work loads impacted project schedules and employee morale.

Annexations and incorporations are reducing the County's service area in urbanizing areas, and also reducing the tax base. The changes are a result of cities forming and annexing in the highest density areas, which means that the county is losing funding at a rate disproportionately greater than the land area that is being lost. This results in uncertainty within the organization about future funding levels for habitat restoration work.

The Endangered Species Act (ESA) listing of chinook salmon in 1999 also impacted the Division. The listing made the process of obtaining permits for habitat enhancement projects much more difficult, because the federal agencies involved were faced with a suddenly increased workload, and because permit submittal requirements and processes were changing. The level of effort required to obtain Corps of Engineers permits increased suddenly for the design teams, which was not foreseen when the project budgets had been established. After the first few years, the cost impact of this change decreased, but has not disappeared. Procedures and expectations within the County have adjusted to the new requirements.

Other cost factors are in themselves neither harmful nor beneficial, but care must be taken to define them explicitly before comparing or analyzing project costs. To give a complete picture, cost tracking must be inclusive of all design, construction, construction oversight, and follow-up costs, including labor, materials, and equipment. Work performed for both the earthwork and planting phases of a project must be included, as well as any construction contract amounts or specialty contractors. The starting and ending points in time of the "project costs" must be defined. Some organizations include planning and monitoring in a project's costs, some do not. These practices may vary depending on the nature of a project. Road or building construction projects may be treated differently than habitat enhancement work. Whether or not overhead costs are routinely captured in an organization's project cost reports is embedded in its accounting practices. Cost tracking may become more difficult in times of organizational upheaval.

DEVELOPING AND TRACKING PROJECT COSTS

For the case studies analyzed for this presentation, "project costs" begin at the time that the design team is formed and has its first meeting. The team begins to charge their costs to a project number that has been established in the County's accounting system. Project costs continue to accrue through design, construction and follow-up periods. Construction usually includes earthwork and planting, and may include multiple phases of each. Follow-up may include plant establishment, invasive species control, and monitoring. Project costs end at the time when the project number is closed out, usually when permit-driven monitoring is complete and any repair work is done. Routine monitoring costs may be estimated and project funds set aside to accomplish the work.

All CPOSA staff time spent working on the project is billed to the project charge number, at a fully burdened rate that varies from about \$40 to \$90 per hour. In the CPOSA section, the overhead multiplier is recalculated each year, in an attempt to accurately reflect the actual cost of providing staff services. It has varied from about 2.3 to almost 2.7. Management and administrative staff do not bill the project – their contribution is paid out of the multiplier applied to staff costs to arrive at the fully burdened labor rate.

The design team may consult other County staff within WLRD, and those professionals generally do not bill the project directly. In particular, Basin Stewards are WLRD employees who are involved in communicating with the public, and with tracking project progress, watershed issues, and citizen concerns. They often work closely with the project team. If legal advice must be sought, the Prosecuting Attorney's staff is available, and does not directly bill the project. These additional resources add considerable value to the project design. The County's accounting system does not automatically track the total level of effort expended to accomplish the project. On the other hand, intranet access to the detailed project charges has been developed since 2001. Both costs and hours expended by the design team and County construction crews are recorded and can be analyzed.

Construction crews work for the Roads Department, and their labor costs are billed to the project at a fully burdened rate, but the multiplier is lower, about 2.0. County construction labor costs range from about $40 to $60 per hour.

Consultants and contractors do not present the same subtleties in project cost tracking, since their overhead costs are always included in the invoices paid. In this sense, it is useful that the County determines and tracks overall costs, and not just wages, for Capital Improvement Project (CIP) staff.

For comparison purposes, and when using project data to estimate future project costs, it is preferable to report hours spent to accomplish project tasks, rather that to compare total dollar figures. It would also be important to define what tasks were accomplished, and whether some work was funded by other sources. "Hours spent" represents the level of effort expended in that particular design/permit/construction environment to accomplish a particular scope of work. Labor rates specific to the organization could then be applied to arrive at budgets or design cost estimates.

Organizations tend to retain and distribute total project cost dollar amounts, as opposed to detailed project cost breakdowns by task. Also these cost figures are retained at certain milestones in a project's lifespan. It is instructive to compare initial planning-level scopes and budgets with budget amounts approved for funding by Council, then with construction estimates and design costs as the project design evolves, then with final costs. All too often, cost information does not specify which costs are included, or whether the cost figures are budgets or actual expenditures. Obviously, it's important when researching project costs to ascertain what has been reported.

Some of the habitat restoration projects are partially funded by grants. Granting agencies typically favor paying construction costs, and may place limitations on what kind of expenditures may be used as matching funds. Grant reporting requirements are usually specific, and specify cost categories that often do not mesh perfectly with the cost categories set up internally within a public agency. The translation effort becomes a project management cost.

Cost Categories

The county accounting system breaks project costs into the following categories:

001- Consultant costs. Does not include consultant contract management costs

002- Acquisition costs to purchase right-of-way, easements, fee title and limited use or access permits

003- Construction costs, by County forces or contracted

006- 1% for art

007- In-house labor

008- Property services support, includes appraisals, negotiation, etc.

009- Construction management, engineering, inspection, closeout

013- Hazardous waste assessment and removal

Expenditures and formal estimates are tracked by the above categories throughout the life of the project. However, for estimating and explaining the costs of projects, the following categories are more useful, because they track the tasks to be done in something closer to chronological order:

Design (all phases)
Construction (all phases)
Follow Through (all phases)

For a project with multiple phases, it is helpful to sequence them chronologically when doing project planning and estimating. Table 1 describes typical costs associated with each phase.

Most habitat enhancement projects include both earthwork (grading, culvert replacement, streambed rehabilitation, LWD placement) and installation of native plants. During the design phase, the earthwork and

Table 1. Typical tasks associated with project design, construction and follow-through

DESIGN			
	Design and Permitting		
		Project assessment	
		Conceptual design	
			Earthwork
			Plantings
		Permit application submittals	
		Plans, specifications, and estimates	
			Earthwork
			Plantings
		Consultant contract management	
	Permit Fees		
	Landowner Relations/Land		
	SEPA		
	Public Involvement		
CONSTRUCTION (consider earthwork and planting separately as two phases)			
	Survey/Staking		
	Construction Access		
	Mobilization		
	Stream Diversion		
	Fish Removal from Work Area		

Table 1. Typical tasks associated with project design, construction and follow-through (cont'd.)

	Erosion and Sedimentation Control	
	Earthwork	
	Materials Procurement	
	LWD Acquisition	
	LWD Placement	
	Structures	
	Construction Management	
		Engineer and biologist on site
FOLLOW THROUGH		
	Maintenance	
		Structures Plant establishment
	Monitoring	
		Permit driven (often limited to plant survival and coverage) Structural stability Evaluating project success
	Closeout	
	Communicating (both within and outside the organization)	

the plantings are interdependent, though the two kinds of work are shown on separate plan sheets. For construction, the two kinds of work are very separate. The planting work is done after the earthwork, by a different work crew, and requires a separate mobilization. The native plants, being alive, have very different needs than other construction materials.

"Landowner relations" includes negotiating right-of-way on the land as well as negotiating the geographical scope of the project. Many habitat projects are on private land, which means that the landowner is brought in as partner. That can take quite a lot of time, and we are not always successful.

SEPA costs are also included in the design phase, and generally amount to $3,000 to $8,000. Costs include preparing the environmental checklist and publishing all notifications, and responding to any comments. Public involvement costs are separate from SEPA because they involve public meetings, such as explaining the project to a Homeowners Association. Often we are dealing with a riparian corridor that was set aside as part of a subdivision, and must get permission from the majority of owners in that subdivision to do the work.

Functionally, it makes sense to lump design and permitting costs together, because the processes are so integrated.

Figure 2. Excavation of defined floodplain for O'Grady creek (Case study project 5)

Engineers on the design team may take the lead in producing project plans, and ecologists take the lead in submitting for permits and consulting with regulatory staff. All team members work together on the design, and ecological issues are central to the content of the design.

The next broad cost category is construction costs. This includes the traditional three sub-categories: materials, equipment, and labor. Depending on the nature of the project, one sub-category may be the dominant cost of the project as a whole. For example, at O'Grady Creek (case study 5), the project involved excavating a flood terrace in a pasture and moving 13,000 cubic yards of earth on site. The quantity of earth to be moved drove the costs of the entire project. Equipment was carefully chosen to do this work most efficiently. Twelve hundred lineal feet of stream was also constructed as part of the project. The streambed meandered, was constructed to exacting grade, and incorporated over 300 pieces of woody debris. Even so, the streambed construction was completed in a fraction of the time needed for the mass earthwork, and was a smaller component of overall project costs.

Figure 3. Crane overcomes tight construction access for delivery truck (Case study project 4)

Access to the project site is an important cost-determining factor. Bringing people and equipment to sensitive, remote sites can be challenging. In some cases it is necessary to build an access road and then decommission it at the end of the project. Figure 3 shows a situation in which an existing access road down a steep ravine was adequate to deliver a concrete box culvert to a stream crossing, but there was no space for the truck and trailer to turn around. The crane placed the culvert and picked the trailer up to turn it in midair.

Another issue is that of stream diversion; usually it's necessary to bypass the flowing water around the work zone. If the

Figure 4. Silt fence along the Sammamish River

Figure 5. Silt curtain in the Sammamish River

stream is diverted, fish and other aquatic life are be removed and relocated prior to the diversion. Regulations regarding monitoring projects during construction have grown stricter recently, which can add labor costs. Equipment can usually be borrowed from the Division's Science and Monitoring workgroup.

Sediment and erosion control measures vary depending on the nature of the project, and deserve special attention near slopes, flowing water, and salmon habitat. Figures 4–5 show work at the confluence of Gold Creek and the Sammamish River. A culvert on the tributary was replaced for fish passage, and the confluence area was completely reshaped. The river has been extensively modified by the Corps of Engineers in the early 1960s. In order to control flooding during the growing season, the low gradient, sinuous, sand-bedded river was straightened and uniformly channelized with a trapezoidal cross-section. The County, nearby cities, and the Corps are working together to restore some habitat diversity, especially at stream confluences. The Sammamish River is a major migration route for five species of salmon, including chinook. Figure 4 shows a silt fence along the river margin to prevent sediment from the bankwork from mobilizing into the river. Figure 5 shows the downstream end of the temporary flow diversion pipe, and a silt curtain in the Sammamish, which was installed to prevent sediment carried by Gold Creek from being mobilized into the mainstem.

Special techniques include placing logs in flowing water along streambanks, soil lifts wrapped in coir fabric, live willow cuttings, and field placement of habitat features such as woody debris complexes or streambed boulders stepped up to serve as "fish ladders." If it is known that an experienced habitat work construction crew will do the work, some uncertainty is removed from the cost estimate.

Special equipment that is frequently employed includes large trackhoes with a thumb, wide tracked vehicles for wetland work, cranes, and helicopters for placing LWD. From experience, project staff have become familiar with the capabilities and costs of some of this specialized equipment. A helicopter costing $5000 per hour may be the least expensive method to install relatively large quantities of LWD, depending on the particulars of the project site. For instance, a helicopter will have minimal impact to a vegetated riparian corridor, but cannot be allowed to fly over housing. Special arrangements must be made to fly over power transmission lines.

Special materials frequently used in instream work include boulders, streambed gravel, and LWD. LWD deserves special consideration, as it can be a major component of project costs. Procuring wood of the appropriate size, shape, and species should be considered separately from the cost of installing it. CPOSA has staff assigned to search for and stockpile wood for the habitat restoration projects, to reduce duplication of effort, and to help assure wood is available to all projects. The most important issues are transportation and timing. Wood can often be obtained for the cost of hauling or harvesting – but those costs will be significant. On one occasion, suitable pieces were available at a construction site as mitigation for development, and could be trucked directly to the project's staging area less than ten miles away without intermediate stockpiling. This is unusual — during the design process it is prudent to estimate the cost of wood based on more difficult circumstances.

Cost Estimating Process

The design team begins work with an initial scope and budget, and as it moves through the design process and the project becomes more defined, the cost estimates become more definite and reliable. It is important to develop a realistic cost framework during project conception that will enable work to begin, and to be completed without seeking additional funds. For similar work in a particular basin, or for a program embracing a group of similar projects, it is possible to have shared funding so that individual project budgets can be flexible.

It is essential for the organization to identify for the project team what the expectations, parameters, and priority of the projects are. Typically, King County desires to maximize habitat benefit for the money expended, and in that case, the design team should have flexibility to assess the scope critically and adjust the budget and schedule accordingly, within certain limits.

First Approximation of Cost

An experienced project manager will often have a sense of the scale of the project and therefore of the cost. For instance, with a basic understanding of the scope, it is possible to estimate whether a project will be about $15,000, about $100,000, or about $400,000. Very soon, it is necessary to develop an estimate based on specific items and quantities. It is helpful to estimate construction costs first, followed by design costs, and then to add follow-up costs. This is because the construction work is more tangible, and elements are more easily visualized and listed. Design costs are primarily labor costs, and depend solely on the level of effort needed to define the work, and then to secure consensus permission to proceed. In addition to labor, materials, and equipment, factors that must be considered include:

- Scale and type of project
- Construction method and access
- Bid process (design-build or general contractor)
- Permits required
- Land ownership
- Land use and watershed issues
- Regulatory constraints and timeframes
- Ecosystem protection

An important phase of any project that is easy to overlook are follow-through costs, including monitoring if the organization has made a policy commitment to that. In addition to permit-driven monitoring requirements, follow-through work items might include consultations with landowners, plant establishment, observations of changes in the ecosystem, and supplemental plantings.

Refining the Estimate

To refine design and construction cost estimates, project managers use a standard CPOSA cost estimating template that is easily modified for each project. Detailed historical cost information is not retained in a central database, but is generally available from project managers who have done similar projects. A reliable source of cost information are the "bid book," which results from an annual request from the County for proposals from vendors and subcontractors. The construction group then has access to these companies on a work order basis. For instance, habitat restoration projects might make use of equipment rental services, erosion control fabrics, and hazardous tree removal services. Another asset is our ability to consult with experienced construction supervisors during the design phase of a project.

Familiarity with the watershed is very helpful in estimating cost and risk. Knowledge of physical characteristics, such as soils and river flow regimes, is useful. Equally important is an understanding of prevailing land uses and concerns of the residents.

PROJECT COST EXAMPLES

Bear-Evans Habitat Improvement Projects

The first three case study projects were part of a comprehensive habitat improvement project in the Bear Creek/Evans Creek system. The watershed is in the vicinity of Redmond, Washington (Microsoft headquarters and rapidly urbanizing) and drains to the Sammamish River. The Bear Creek Basin Plan was adopted and funded by King County Council in 1990. Reconnaissance and planning had begun in the 1980's. This watershed was one of the first comprehensive Basin Plans undertaken by King County because it encompassed significant natural resources, including a viable run of wild salmon, and was under threat from rapid development.

The Bear/Evans Habitat Enhancement Project identified 14 miles of stream in the watershed along Bear, Evans, Cottage Lake, and Mackey Creeks. The scope included identifying the specific problems along the stream reaches, and then working with interested landowners to resolve those issues.

In the first year (1993), a team of habitat biologists walked the entire 14 miles of stream reach, and kept detailed data on in-stream habitat features and riparian vegetation. Before the stream walk, each of the 350 property owners involved were contacted for permission to enter their property. Access permission (and denial) was tracked on maps. Habitat features were mapped onto assessor's maps by hand, for purposes of project identification. Many of the logistical issues encountered during the study phase could be overcome much more quickly with GIS capabilities that the County now enjoys.

Potential project sites, often involving more than one landowner, were identified based on the observed problems. The sites were prioritized in order of the severity and importance of the problems using a weighted equation that the project team developed. Landowners were contacted to discern their interest. Two pilot projects and about 15 habitat improvement projects ranging in cost from $5,000 to $400,000 were eventually completed. Additional potential projects await funding or new owners more interested in working with the County.

Landowner perspective and needs proved to be the most significant determinant of whether a project was feasible. Sites with significant problems generally have those problems as a result of past land management. Some of our most successful project were on sites with new owners.

County staff worked with a design consultant during the study phase of the project, and on some of the individual project sites. The costs of the study phase are not included in the individual case study project costs.

Figure 6. Bank stabilization work on Bear Creek to improve salmon habitat. The star on the watershed map indicates the approximate project location.

Case Study 1. Bear Creek at Conrad Olson Farm, In-stream and Floodplain Enhancements

Conrad Olson Farm is a historic homestead on Bear Creek, and was purchased in 1995 by the City of Redmond as part of their park system and a proposed regional trail. Project design, construction, and plantings were completed in January through November 1995. The permit-driven monitoring period lasts five years.

The 8-acre site (Figure 6) includes about 1400 lineal feet of Bear Creek, about half of which was treated with instream and bank stabilization features. Features included deflector logs with rootwads, keyed into the banks and anchored with boulders; live willow cutting mats; willow stakes; coir wraps and logs installed parallel to the bank and anchored with rebar; instream habitat logs; and toe rock (rounded boulders) in some locations. Design plans were produced by an experienced consultant, with involvement of a CPOSA engineer and ecologist.

Table 2. Conrad Olson Farm project costs

ITEM	COST
Design	$118,000
Land	$2,600
Permits	$19,600
SEPA	$10,800
DESIGN TOTAL	**$151,000**
County Force Construction	$11,000
Construction Contract	$135,000
Volunteer & WCC Planting	$31,000
Construction Management	$40,500
CONSTRUCTION TOTAL	**$217,500**
1996 Replanting	$14,000
Irrigation System	$11,500
Plant Maintenance and Monitoring (budgeted over 5 years)	$50,000
FOLLOW THROUGH TOTAL	**$75,500**
GRAND TOTAL	**$444,000**

The project was undertaken under terms of a Memorandum of Understanding with the City of Redmond. Project costs are itemized in Table 2. Land costs ($2,600) reflect time spent negotiating the agreement language and attending Council meetings. The construction management costs ($40,500) cover one engineer and one biologist who were on site 100% of the time during the project, and the project manager's time.

Of the seven treatment reaches, six were built under a bid process by a general contractor. One reach involved erosion near a County bridge at the upstream end of the site, and was build by County maintenance crews. In addition to reinforcing the bridge abutment with rip-rap, about 150 feet of eroding bank immediately downstream was treated with LWD deflector logs, bank logs, and coir wraps layered with live willow cuttings from an on-site grove. Many of the techniques in the seven treatment reaches were somewhat experimental. Most have performed well, with the exception of a series of logs that were cabled to boulders in mid-stream. A meander cut-off has occurred near the middle of the stream reach, and changed conditions at what was expected to be a deposition zone immediately upstream. This caused some toe rock to be undercut, and left a willow mat too far above the water level to grow. Willow stakes were installed the next year and are doing well. Even with unexpected changes, the work is satisfactory, and no further repairs are planned.

About three acres of the floodplain was planted with native trees and shrubs, and almost two acres were cleared of dense stands of Himalayan blackberry. A well-attended volunteer planting day resulted in the installation of thousands of plants very quickly. The WCC crew did the required site prep and layout, and follow-up plantings and clean-up after the event. Public involvement staff who planned and publicized the event did not charge their time to the project. As a result, the majority of costs shown are for plants and mulch. Planting design costs are lumped with the overall design costs.

Plantings were done in autumn 1995. The following March, a 25-year recurrence interval flood pulled about 30% of the new plantings in the floodplain out of the ground. Many were simply tamped back in, but about 1000 additional shrubs were purchased and installed.

A temporary irrigation system was designed and installed and was in use for the first two summers. Fortunately, city water was available on the farm. On most habitat sites, water must be withdrawn from the river or trucked to the site. In addition, the new plantings were cared for through a volunteer program called Habitat Partners. Pairs of volunteers adopted specific parts of the site, and returned regularly to weed the plants. Plant survival at the end of the monitoring period was over 90%, which is outstanding. In comparison, on sites that are not cared for, our monitoring reports show 30% to 50% survival. We have learned through experience that it is very important to take care to establish the native plants we bring to a site.

Case Study 2. Bear Creek at Conover, Bank Stabilization and LWD

This project on Bear Creek presented a bank erosion site about 100 feet long that had been identified as a habitat problem during the study phase of the project. The land use was a single-family residence, with horse acreage. Horses were grazing up to the bank edge, so riparian vegetation on one side of the creek was almost non-existent. A modified version of one of the same bank treatments at Conrad Olson Farm was used, with deflector logs including rootwads. Boulders, coir wraps, and willow cuttings were incorporated into the bank.

This was, in a sense, an opportunity project because on first interview, this property's owners were not interested in working with the county. In fact, they had already refused a request from the King County Roads Department to accept cash for use of their land as a mitigation site. They had very clearly stated that they did not want the county involved in their land. However, the 1996 flood changed their mind. They lost a tree and about 15 feet of land to bank erosion right in front of their house. They called the Basin Steward and asked to be included in the habitat enhancement program. As at the Conrad Olson farm, design and construction were completed within one year. This was only possible because the pre-project planning and funding were already in place.

It was of primary importance to the landowners that the project would stabilize their bank, but they had no objection to a softer design that did not rely on rip-rap armoring. They agreed to keep the horses out of the small streamside pasture, and the riparian area was planted with native trees and shrubs.

Table 3. Bear Creek at Conover bank stabilization and LWD project costs

ITEM	COST
Design	$28,000
Easements	$1,400
Permits	$8,200
SEPA	$2,800
DESIGN TOTAL	**$40,400**
County Force Construction	$24,600
Construction Contract	NA
WCC	$3,600
Construction Management	$11,400
CONSTRUCTION TOTAL	**$52,600**
GRAND TOTAL	**$93,000**

Easement costs shown in Table 3 are for a Temporary Construction Easement from the landowners, which is required by the County in order to work on private land. Permit costs include fees paid, and also an estimate of the time spent specifically preparing permit submittals.

The same King County crew that had done the work downstream of the bridge on the Conrad Olson Farm the summer before did the construction work. Construction Management costs include an engineer and a biologist on-site for the entire construction time, about a week. The Washington Conservation Corps (WCC) crew spent an additional week doing clean-up work and planting, which was very cost-effective.

Case Study 3. Rutherford Creek Streambed Rehabilitation

Rutherford Creek is a tributary to Evans Creek in the Bear/Evans basin. Historically, it had been an important spawning channel for coho salmon, with a median value of 335 spawners observed per mile in surveys conducted between 1976 and 1978. In the project reach, the streambed had incised up to five feet deep, compared to a previous cross-section depth of almost two feet. The growing streambed incision was measured by a monitoring team working in connection with a proposed large residential development a few miles upstream in the watershed. The incising reach was relatively short but was growing longer, with a 3.5-foot high headcut at its upper end. Both the headcut and increasing velocities due to the changing stream morphology were preventing fish passage.

The county had noticed the problem about three years earlier, when the incision was less severe. A project involving check dams built of small rock (about 1 foot in diameter), placed by hand, had been built in an effort to solve the problem. The check dams blew out and the incision continued, so that the cross-section of the stream was a deepening trench about 5 feet wide at the top and 2 feet wide at the bottom.

The 1998 design involved restoring the stream's original cross-section, based on observations of upstream and downstream reaches, with a matrix of streambed material that would be competent to withstand erosive forces. This project involved about 600 feet of streambed reconstruction, incorporating LWD and boulder weirs. Streambed material that had been sluiced out of the rapidly incising reach and

Figure 7. The two photos to the left show the streambed work in progress. The photo on the right was taken about one week after construction.

deposited on a downstream farmer's field was incorporated into the new streambed. The project (Figure 7) was designed and completed within the year, because the funding, the design team, and the watershed planning were already in place.

As indicated in Table 4, easement costs and landowner negotiations costs were low ($800), because the incising reach was located in a subdivision within a native-growth protection easement which was dedicated to King County for uses consistent with the project.

The reach presented an interesting construction access challenge, on account of the mature native vegetation in the riparian corridor, including big-leaf maple, western red cedar, and douglas fir trees, vine maple along the stream banks, and sword fern and salal in the understory. About halfway down the project reach, an outlet pipe from the subdivision's R/D pond (maintained by King County) ran to the stream. Once the design team learned that Rutherford Creek typically went subsurface through the project reach in the summer, it was decided to use the streambed itself as construction access. The empty R/D pond was used as a stockpile and gravel mixing area.

Table 4. Rutherford Creek stream rehabilitation project costs

ITEM	COST
Design	$44,500
Easements	$800
Permits	$3,600
SEPA	$2,700
DESIGN TOTAL	**$51,600**
County Force Construction	$33,100
Construction Contract	NA
WCC	$10,600
Construction Management	$18,200
CONSTRUCTION TOTAL	**$61,900**
GRAND TOTAL	**$113,500**

About 40 pieces of woody debris were integrated into the new streambed. The completely rebuilt stream channel was intended to have a step-pool morphology. Boulder wedges, constructed of a well-graded mix that included rock up to 3 feet in diameter, were incorporated into the fill at approximately 40-foot intervals. The wedges are not obvious in the finished project, and are intended to act as catch-points in controlling the stream gradient.

The WCC crew spent a few days before the project tying streamside vegetation out of the way of the heavy equipment. After the heavy earthmoving was done, the WCC moved some streambed material by hand, and planted disturbed areas with native plants.

The project reach has been monitored since construction, and includes several measured cross-sections. There has been no evidence of channel expansion or formation of nickpoints.

O'Grady Creek Projects

In contrast to the preceding case studies, the following two projects on O'Grady Creek were built under accelerated schedules and very uncertain permitting environments. As a result of these and other factors, costs are noticeably higher.

O'Grady Creek flows to a slow-moving sidechannel of the Green River, which joins the mainstem about a quarter-mile away. The project site is on O'Grady Creek less than a mile upstream of the confluence. Coho, chum, and steelhead inhabit the creek. The river is also used by chinook and sockeye. The project site is within an 880-acre open-space riparian park.

Both projects were funded in March 1999, shortly after chinook salmon were listed as threatened under the ESA. A basin plan has not been completed for the Green River, and the two projects were activated in response to the County Council's wish to demonstrate their concern for threatened resources. The desire was to finish the design work quickly and build both projects before the year was over.

Ironically, the very action (the ESA listing) that gave these projects their urgency and funding also added additional steps and uncertainty to their design and permitting. The County instituted an internal Biological Review Panel in order to ensure compliance with the Federal requirements. A Biological Assessment was prepared for both projects, and submitted to the Corps of Engineers the first week of July, along with project plans. In spite of a vastly increased workload, Corps staff was able to visit the site in August. They expressed concerns about possible impacts to the wetlands adjacent to O'Grady Creek that could result from the proposed work to improve instream habitat stability at the alluvial fan. As a result, the second project was not built until 2000.

For both projects, landowner negotiations increased design costs. The property is managed by King County Parks, and a representative from Parks was included in the design meetings. She contributed to design decisions, and made sure that Parks' long term interests as stewards of the land were protected. One issue was that the habitat improvements must not result in increased maintenance responsibilities for Parks. Accordingly, the design team set aside money for plant maintenance and adaptive management, to make sure that a riparian forest would be fully established before the CIP project was closed out. A second issue proved more troublesome, and resulted in many hours of negotiation before it was resolved. It was a labor dispute between the two maintenance shops over the right to do the work. Meetings probably added only about $3,000 to the direct project costs, but added greatly to pre-construction stress levels and uncertainty. (The upper level managers who eventually settled the matter do not bill to the project budget.) These costs are lumped with overall design costs in Tables 5–6.

Design and construction projects often generate unexpected problems, and habitat restoration projects are no exception. It's axiomatic that contingency funds and some float in the schedule are highly desirable.

Figure 8. Culvert replacement for fish passage at O'Grady Creek (Photos taken immediately before and after construction)

Figure 9. Looking downstream from the new culvert at the rebuilt reach of O'Grady Creek after construction. The streambed here is about three feet higher than the eroded streambed. Buried boulder wedges create a stepped reach of pools for fish passage. LWD was added for habitat diversity.

Case Study 4. O'Grady Creek Culvert Replacement for Fish Passage

The O'Grady Creek culvert replacement project was substantially completed in September 1999. A 30-inch diameter corrugated metal culvert that blocked fish passage was replaced with a 10-foot wide concrete box culvert. Over 200 lineal feet of streambed was reconstructed in order to eliminate the 3.6-foot incision immediately downstream of the old culvert. The design concept for the reconstructed stream reach was to build a series of pools and boulder wedges, providing fish passage in both the short term and in the future, when sediment transport is expected to fill the pools with gravel (Figure 9). This strategy minimized imported fill and buffered the downstream system from the movement of the upstream sediment wedge that the old culvert had forced. About 50 large logs with rootwads were incorporated into the pools so as to create local scour pockets and improve habitat diversity in the project reach.

In addition to the work at the main culvert, 3 smaller culverts were removed from tributaries emerging from the toe of an adjacent escarpment, and a half-mile long existing access road was decommissioned. In order to demonstrate competency in habitat work, Parks maintenance donated about $17,000 worth of labor and equipment to do

Table 5. O'Grady Creek culvert replacement project costs

ITEM	COST
DESIGN TOTAL	**$99,000**
County Force Construction	$68,000
Salvaged Culvert ($8,000 value)	$0
WCC Planting	$3,000
Construction Management	$42,000
CONSTRUCTION TOTAL	**$113,000**
GRAND TOTAL	**$212,000**

the work on the small culverts. The fact that the two work sites were physically separate helped to avoid a labor union dispute. The extra work and costs are not included in Table 5.

Native trees and shrubs were planted in all disturbed areas in November 1999. The same month, coho and chum salmon were observed using the rebuilt stream reach, and spawning was observed upstream of the new culvert. The project was successful, but more expensive than anticipated.

Because the design effort was integrated with the wetland and stream enhancement project, design costs are not broken down into sub-categories for either of the two projects. Permit submittal costs and consultation costs both within and outside of King county are included in the $99,000 total shown in Table 5. The cost of preparing the Biological Assessment is not shown here, because the same document was required for the more extensive Stream Habitat Enhancement project. Site survey costs are not included either, for similar reasons. The new concrete box culvert was salvaged from a Roads project for which it was no longer needed. Costs of delivering and placing the culvert are included in the $68,000 County Force construction cost. Construction management costs are relatively high, because there were at least two design team members on site at all times. Often, an additional ecologist was on-site collecting water quality data and assisting with the removal of the three small culverts.

Case Study 5. O'Grady Creek Wetland and Stream Habitat Enhancements

About 400 feet downstream of the culvert replacement project on O'Grady Creek, the stream gradient begins to decrease noticeably as the creek begins its transition onto the flat gradient of the valley bottom (Figure 10). Looking downstream over the alluvial fan, it is possible to see sediment deposition and evidence of channel movement, both very natural processes. The area has been identified as a fish passage problem because of frequent stranding of adult and juvenile salmon on the pasture turf of the abandoned homestead. For instance, in February of 1996, sediment deposited by storm flows forced O'Grady Creek to leave its channel. It flowed in a broad sheet over the pasture and was not able to establish a new channel to connect to the Green River. The water infiltrated into the pasture, stranding fish and cutting off fish passage to the upper system.

The project involved constructing about 1200 feet of new stream channel within an excavated floodplain bench. The excavated soil was placed on site in gentle mounds along the margin of the bench. The stream channel was constructed in the lowest part of the excavated bench, and incorporated over 300 pieces of woody debris partially embedded in the earth. The design called for planting live willow stakes along the stream banks, and waiting for two growing seasons (until summer 2002) before connecting the new stream channel to flowing water.

The total graded area on site was about 8 acres, which were planted in native trees and shrubs. The goal of the plantings is to establish a healthy riparian forest with a patch-

Figure 10. Problems associated with the alluvial fan reach on O'Grady Creek

Figure 11. Earthwork to create new stream alignment with floodplain bench, May 2000. Wetland area is to the left side of the photo, and the side channel of the Green River is behind the trees in the background.

Figure 12. Volunteer planting event for O'Grady Creek stream enhancement project, November 2000. The new stream channel is visible as it meanders toward the sidechannel of the Green River. It was not connected to flowing water until May 2002.

work of different plant communities. Experimental plots designed to overcome reed canarygrass infestations were installed in the wetland buffer. Existing wetland emergent and scrub-shrub plant communities were enhanced with additional plantings.

The first phase of the earthwork was completed in May 2000 (Figure 11). Surrounding cottonwood trees were just going to seed and covered the site thoroughly. The planting plan was adjusted to take advantage of this windfall. In November 2000, 180 people attended a volunteer planting event on the site (Figure 12). With the assistance of the WCC crew, about 2500 trees and 1000 shrubs were planted.

Design costs for this project were truly stupendous (Table 6). The additional expenses can be attributed mainly to organizational factors. Efficiencies were expected and realized from starting two projects on the same site with the same design team. Costs such as preparing the Biological Assessment and a detailed site survey were charged to the larger project rather than the culvert replacement project. Later in the design process, especially after the projects were split apart in August after input from

Table 6. O'Grady Creek wetland and stream habitat enhancements project costs

ITEM	COST
Design	$342,000
Planting Design	$9,000
Survey (also used for culvert project)	$28,000
DESIGN TOTAL	$379,000
County Force Construction, 2000 (Roads)	$67,000
County Force Construction, 2002 (Parks)	$35,000
Construction Contract	NA
CONSTRUCTION TOTAL	**$169,000**
Volunteer and WCC Planting, 2000	$34,000
2003 Plantings (set aside)	$25,000
Construction Management	$33,000
Plant maintenance and Monitoring	$25,000
FOLLOW THROUGH TOTAL	**$72,000**
GRAND TOTAL	**$620,000**

the Corps of Engineers, costs were more clearly separated.

Internal uncertainty within King County created extra consultations in an attempt to control potential liability resulting from the ESA listing. Staff has since gained experience in working with the Federal Services and in preparing documentation such as the Biological Assessments.

After the projects were split apart, the design team focused their effort on the culvert replacement project. Once it was completed near the end of September, the team assessed the concerns the Corps had expressed about wetland impacts. Flow and ground saturation measurements were made before and after the seasonal rains began in November. The wetland and its associated hydrology were mapped as closely as possible. Wetlands specialists within WLRD were consulted. The team concluded that it would not be able to quantify potential impacts to the wetland because of the complex and dynamic nature of the site. In particular, the ever-changing pattern of distributary flows and the multiple sources of water feeding the wetland would make it difficult to do a conclusive analysis over a period of years. We could not gather enough data in one year to satisfy all the possibilities.

The project was redesigned to minimize wetland impacts. Significant enhancements to the wetland plant community were added to the project scope, and additional funds were set aside for monitoring and adaptive management. The details of the stream channel design at the upstream and downstream end were also refined.

A proposal to build the project in February in order to meet a funding deadline was studied in detail and ultimately rejected by the internal Biological Review Panel, because of the risk of rain causing sediment and erosion control problems. During the period that the project was delayed, extra time was required for design because of staff turnover.

The project is on track to be a success. Juvenile fish began using the stream channel immediately after it was opened to flowing water in May 2002. Adult salmon continue to access the upstream reaches of O'Grady Creek and spawning has been observed every year. In 2003, the cottonwood seedlings are generally about 3 feet high. The biggest issues are plant survival in the drier upland areas and deer predation. Also, a vigorous crop of thistle and tansy from the adjacent infested pasture has taken over large areas of the site. It is expected that the trees will eventually overcome the weeds. A follow-up volunteer planting is planned in Autumn 2003, and site maintenance (with project funds) will continue for an additional two years.

CONCLUSION

Habitat restoration work in urbanized areas requires a different approach than does work in less densely inhabited areas. The WLRD in King County has developed a strategy for building habitat enhancement projects within urbanizing watersheds. Design, permitting, and construction expertise resides in a workgroup that can draw on County-wide resources, including planning work carried out by the Division. Ideally, stream enhancement work is carried out in the context of a watershed-wide assessment of the causes of habitat degradation.

It is very important to focus on the organization of the design teams, so that people acquire familiarity with the physical and social characteristics of the watersheds where they work. Ecological and regulatory issues, and construction feasibility issues are best addressed from the beginning of the design team's work. The team members should be directly involved in working with construction crews. A design/build project management approach is desirable. Care must be taken to maintain native plants in the first years after they are installed.

It is important to design projects on a firm foundation of past experience, incorporating the lessons learned and data gathered from previous projects. The design approach must acknowledge the dynamic character of natural stream systems and work within the context of landscape processes. Projects should be modeled on natural templates, utilize native materials, and use the least invasive construction method feasible. Many habitat restoration projects are innovative in one respect or another. Project teams need some flexibility in scope, schedule, or budget in order to deal effectively with the uncertainties associated with new solutions.

Projects are designed within ecological constraints, and also within institutional parameters. In an urbanized setting, dealing with large numbers of project participants is an important issue, and it is crucial to budget sufficient staff time to meet and negotiate with landowners and other stakeholders, such as tribes, cities, and regulatory agencies. This staff time can increase project costs, as can another characteristic of urban basins: the lack of plentiful materials such as woody debris near the project site.

Local government agencies are often the proponents of habitat enhancement projects. For good reasons, they tend to be risk averse and they need to respond to the valid concerns raised by all stakeholders. Consensus-building can be expensive. Solving these problems while maintaining low project costs has required creativity and good planning.

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